

LCD Monitors

**Speech Recognition
Technology**

Lithium-ion Batteries

Catalytic Converters

Synthetic Polymers

**Shatterproof
Windshields**

Adjustable Seats

Center Brake Light

Transistor

**Airbag Deployment
Sensors**

Remote Car Locks

CD Players

Extended Tire Life

GPS

Car Bumpers

AUTOMOTIVE APPLICATIONS OF BASIC RESEARCH

Federally funded research laid the foundation for many technological advances contained in the modern car





LCD Monitors: NIH, NSF, and DOD funded the basic liquid crystal research that led to the creation of thin film transistor liquid crystal displays (LCD) in 1988. The thinner displays make possible such in-car features as back-up cameras, television, DVDs, video games, and GPS.

Speech Recognition Technology: NSF and the Defense Department's DARPA funded initial research in the 1980s leading to the development of speech activation and recognition technology. The technology is used to control music, navigation, and phone devices for safer driving.

Lithium-Ion Batteries: The rechargeable lithium-ion (Li-ion) battery, developed in 1990, stemmed from DOE basic research funding in electrochemistry. The Li-ion battery is an energy-efficient alternative for powering hybrid and electric cars. This battery allows for the extended range capabilities in the 2011 Chevrolet Volt.

Catalytic Converters: Supported by NSF, Art Heuer at Case Western Reserve University developed zirconium dioxide-based ceramics while researching ceramics capable of surviving extreme conditions. Used in catalytic converters in the car exhaust system, these strong ceramics increase gas mileage by preventing cracking.

Synthetic Polymers: In the 1950s, NSF funded researchers at the University of Akron studying durable forms of rubber. These researchers were able to transition to other synthetic polymers,

resulting in many applications such as automotive components.

Shatterproof Windshields: Neutron-scattering instruments funded by DOE allow researchers to study the structure of various compounds. This research has contributed to the development of polymers, including polyvinyl butyral, which is the resin used to create shatterproof glass.

Power windows: Neutron-scattering instruments funded by DOE allow researchers to study the structure of various compounds. This research has led to the development of new types of magnets, which are a critical component of the small yet powerful motor used to raise and lower car windows.

Center Brake Light: In 1974, social scientist John Voevodsky found that a third brake light resulted in 60.6% fewer rear-end collisions, 61.1% fewer injuries to drivers, and 61.8% less in repair costs. After finding similar results in a repeat study, the National Highway Traffic Safety Administration now requires the third brake light.

Semiconductors: Though semiconductors first appeared around 1900, it wasn't until the development of basic research into quantum mechanics that scientists could understand this phenomenon and begin to improve semiconductor design. Today, semiconductors are the key component of every computer chip, including the chip that handles everything in a car from the fuel efficiency to the power steering to the air conditioning.

Airbag Deployment Sensors: Micro-electro-mechanical systems (MEMS) allow for the creation of tiny motors used in airbag deployment sensors. Both NSF and NASA funded basic and applied research on MEMS accelerometers, a critical component in triggering airbags.

Remote Car Locks: Basic research supported by DOE's Office of Science contributed to the

development of non-rechargeable lithium batteries, which offer high energy storage capacity. These batteries are used in remote car locks to ensure their long life.

CD Players: CD players rely on data compression algorithms, the product of NSF-funded exploratory research. Irving Reed, Gustave Solomon and Elwyn Berlekamp at UC-Berkeley created the codes and algorithms that led to many applications, like the CD player, decades later.

Tire Performance: NSF has fostered development of nanoscience by leading the National Nanotechnology Initiative (NNI) and investing in university research. Nanotechnology breakthroughs include high-performance rubber additives for tires, such as Nanoprene.

Global Positioning System (GPS): The development of GPS technology utilized basic and applied research (microwave research, recognition of the Doppler Shift, atomic clocks, satellite launching technology) supported by DOD and other federal agencies and carried out at universities.

Car Bumpers: Reaction injection molding (RIM) creates resilient plastics used in car bumpers, resulting in reduced repairs, insurance costs, and fuel consumption. RIM research came out of university-based materials research laboratories, funded by DOD, NSF, and NASA.

"The limitation of focused or problem-oriented research becomes apparent in the following observation: If you know what you are looking for, you are limited by what you know."

--Nobel Laureate Jerome I. Friedman, MIT physics professor